SUPPLEMENT

TO

THE JOURNAL OF

THE INDIAN MATHEMATICAL SOCIETY

Volume XVII.

REPORT

OF

THE SIXTH CONFERENCE

OF

THE INDIAN MATHEMATICAL SOCIETY

HELD AT NAGPUR IN DECEMBER, 1928.

MADRAS :
PRINTED BY SRINIVASA VARADACHARI & CO.
4, MOUNT ROAD.

1929.

SIXTH CONFERENCE

The Indian Mathematical Society

Nagpur, 25th December 1928.

Chairs :—1. [illegible]. 2. D. D. Kapadia. 3. G. S. Chowla. 4. Balakram. 5. V. Ramaswamy Aiyar.
6. Sir B. K. Bose. 7. C. V. Raman. 8. S. R. U. Savoor. 9. T. Suryanarayana.
10. K. S. Kuppuswami Aiyangar.

Standing. *1st Row* :—1. S. W. Chinchalkar. 2. R. Vaidyanathaswamy. 3. K. R. Gunjikar. 4. A. A. Krishnaswami Aiyangar.
5. M. V. Arunachala Sastri. 6. G. V. Krishnaswami Aiyangar. 7. T. V. Sunderesan. 8. S. B. Belekar.
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REPORT OF THE SIXTH CONFERENCE

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INDIAN MATHEMATICAL SOCIETY.

NAGPUR, DECEMBER 1928.

The Sixth Conference of the Indian Mathematical Society was held in the University Buildings, Nagpur, on the 24th 25th and 26th December, 1928. There were about 40 delegates who had come from different parts of India to attend the Conference, several of whom were accommodated in the New Science College Hostel. The Local Committee and other local members had taken great pains to ensure a successful session, and the delegates were well pleased with the reception accorded to them and the arrangements made for their convenience.

A set of student volunteers were in attendance throughout and rendered very willing and valuable service.

The Opening Day.

The opening function took place at 12 noon on 24th December in the Nagpur University Hall, where in addition to the delegates, many distinguished ladies and gentlemen had gathered in response to the invitation issued by the Reception Committee.

The proceedings commenced with an Address of Welcome by the Chairman of the Reception Committee, the Hon'ble Sir Shankar Rao Chitnavis, *Kt.*, B.A., I.S.O. Then the message of His Excellency the Governor, Central Provinces and Berar was read out. This was followed by the reading of the Report of the Society by the Honorary Joint Secretary, Rai Bahadur Gopal Singh Chowla, M.A., I.E.S. The Inaugural Address of the Society was delivered by Dr. C. V. Raman, M.A., D.Sc., F.R.S.

In the evening there was an informal discussion of the affairs of the Society, after which there was a Garden Party in honour of the members and visitors, arranged by the Reception Committee.

Second and Third Days.

On the second day the papers presented to the Conference were read both in the morning and the afternoon, till 4 P.M, when a group photograph was taken. In the evening there was a public lecture on Meteorology by Dr. S. R. U. Savoor, D. Sc., F.R.A.S., of the Presidency College, Madras, illustrated with a large number of lantern slides.

The reading of the papers was resumed on the morning of the third day and continued till 11 A.M. when the Conference formally concluded with a vote of thanks to His Excellency the Governor of the Central Provinces and Berar, Sir B. K. Bose, K.C.I.E., M.A., LL.B., Vice-Chancellor of the Nagpur University, the Chairman and members of the Reception Committee, and the volunteers.

The places of interest visited by the delegates included the local electrically-driven Cotton Mills, Ramtek Hill and Temple, Mansur and Kandri Manganese Mines and the Khindshi Lake. Tea and light refreshments were served at the Dak Bungalow overlooking Khindshi Lake.

List of Papers presented to the Conference.

1. **Audinarayanan, S**, Research Student, Madras University: *The polo-conic of an order conic with respect to an order cubic.*
2. ——————: *The syzygetic pencil of cubics.*
3. **Balakram**: *On numbers which can be expressed as the sum of two cubes in two different ways.*
4. **Bhimasena Rao, M.**, Central College, Bangalore: *The parametric representation of Steiner Cubics associated with a triangle.*
5. —————— and **Venkatarama Iyer, M.**, Collegiate High School, Mysore. *A theorem concerning circles touching the nine points circle.*
6. **Chowla, G. S.**, Government College, Lahore: *Landen's Transformation.*
7. **Chowla, S. D.**, Research Student, Lahore University: *Some properties of positive integers.*

8. **Chowla, S. D.**, Research Student, Lahore University: *Some identities in the theory of numbers.*

9. ———————: *Some expressions for the class number of binary quadratic forms.*

10. **Dhar, S. C.**, Nagpur University: *On the quasi-periodic solutions of Mathieu's equation and the integral equation connected with them.*

11. **Krishnaswamy Ayyangar, A. A.**, Collegiate High School, Mysore: *On the minimal circular enclosure of a given set of points.*

12. ———————: *Triangles invariant in species for orthogonal projection.*

13. ———————: *Bhaskara and the Samslishtakuttaka.*

14. **Krishnaswamy Ayyangar, G. V.**, Chidambaram College: *The metric of circle-geometry.*

15. **Kuppuswamy Iyengar, K. S.**, Central College, Bangalore: *Generalisation of the Schwarzian and Minkowski inequalities.*

16. ———————: *On a theorem of Hardy.*

17. ———————: *Cesaro's theorem and its generalisation.*

18. **Narasinga Rao, A.**, University of Madras: *On certain cubic transformations in circle space connected with the theory of the pedal circle.*

19. **Purshottam, S.**: *The half circle of curvature of a conic.*

20. ———————: *Inverse Trigonometric functions.*

21. **Patrachariar, K. S.**, Govt. College, Coimbatore: *The Cardioid.*

22. **Ramaswamy Aiyar, V.**, Chittoor: *The gradient symmetric.*

23. ———————: *The Elliptic generation of the Cartesian Oval.*

24. **Savoor, S. R. U.**, Presidency College, Madras: *Hamilton's characteristic and principal functions and the part they play in quantum mechanics.*

25. ———————: *On the attraction of an oblate spheroid at a point on the polar axis.*

26. **Sivasankaranarayana Pillai, S.**, Research Student, University of Madras: *On the smallest primitive root of a given prime.*

27. ———————: *On a function analogous to* $G(k)$.

28. ———————: *On some functions connected with* $\phi(n)$.

29. **Srinivasiengar, C. N.,** Central College, Bangalore: *Envelopes of systems of surfaces and of skew curves.*

30 ——————: *Singular solutions of the differential equation of the second order* : $f(x, y, y', y'') = 0$.

31. **Srinivasan, G. A,** Presidency College, Madras: *Some extensions of the properties of the pedal line.*

32. **Srivastava, P. L,** University of Allahabad: *On an expression for a class of integral functions.*

33. **Suryanarayana, T.,** Government College, Rajahmundry: *On the flow of heat in a rod composed of two materials, due to an impulsive source.*

34. **Vaidyanathan, M.,** Pachaiyappa's College, Madras: *On the probability of* $y \leqslant u$ *where* $y = f(x)$ *and the frequency of* x *is given.*

35 **Vaidyanathaswamy, R.,** University of Madras: *The theory of Smith's determinant.*

36. **Vijayaraghavan, T.,** Madras: *A Diophantine problem.*

37. **Varma, Rama Shanker,** Research Scholar, University of Allahabad: *On the periodic solutions of the differential equation* :

$$\frac{d^2y}{dx^2} + (A + 16q \cos 2nx)y = 0.$$

38. ——————: *On the solutions of the differential equation*:

$$\frac{d^2y}{dx^2} + (A + 16q \cos 2nx)y = 0.$$

39. ——————: *On the application of the differential equation* $\frac{d^2y}{dx^2} + (A + 16q \cos 2nx)y = 0$ *and in particular (for* $r = 1$) *of Mathieu's Differential Equation to a problem in tidal waves.*

Welcome Address of the Hon'ble Sir Shankar Rao Chitnavis, *Kt.*, B.A., I.S.O.

Chairman, Reception Committee.

The pleasant duty of welcoming you all, on behalf of the Reception Committee, to this Conference of the Indian Mathematical Society has been entrusted to me by my kind friends. I esteem it a proud privilege to offer you a very warm welcome to this historic city of Nagpur, for ever green with the memory of Bhonslas. We are only too conscious of our deficiencies in providing for your comforts and conveniences. But I assure you that our welcome proceeds from the heart. I hope that you will not, therefore, mind the numerous shortcomings that will be found in our arrangements for your reception and accept our hospitality in a spirit of indulgent tolerance.

I have accepted this honour with great diffidence. It is nearly 45 years since I have had anything to do with mathematics. No doubt it was my special subject for the B.A. degree examination. But, my later life has mostly been spent in non-academic Government service, and I have forgotton what little I learnt in college. I therefore find myself in a most anomalous position.

" All science," wrote Herbert Spencer, " is prevision, and all prevision ultimately helps us, in greater or less degree, to achieve the good and avoid the bad." Elsewhere he has told us that " we have a veritable revelation in science—a continuous disclosure of the established order of the Universe." This disclosure it is the duty of every one to verify as far as in him lies, and having verified to receive with all humility. These words summarise the modern and western conceptions of science. Let me recall the ancient and more profound view contained in the Upanishads, where it is said that of the three worlds, the world of the Gods is conquered by science, and it is added that " the world of the Gods is the best among the worlds. Therefore they praise science."

It has long been apparent that an era of far-reaching scientific discovery has begun. Day by day, to silent workers and seekers, Nature is slowly revealing her secrets and the mysteries of the Universe are being

disclosed. Year by year additions are being made to the sum total of human knowledge and a new land of promise is being opened out. It is really an era of stupendous discoveries and unparalleled inventions, and if we are justified in trying to gauge the future by the immediate past, a period of exceptional intellectual activity and scientific competition lies ahead of us. Those countries which fail to keep pace with it will lag behind not only in the march to progress, but even in what may be within a few years the essential conditions of serviceable existence, and this holds true even in a country of conservative traditions like India.

The original investigation of truth, the discovery of the secrets of Nature, the opening of new paths for the march of the human mind—this is the work not of the multitude but of a select few. Such leaders of thought and discoverers of science must ever be a small minority; they form what the Greeks called an aristocracy; that is a body of the best men in intellectual power and strength of character. While an aristocracy of birth hardens and narrows down to an exclusive caste in a few generations, an aristocracy in the ancient Greek sense of the word is the need of every people that wishes to live and advance in the world.

If we are to rise to the lofty destiny that ought to be ours, if Indians of the highest capacity are to take their places as peers among the world's intellectual leaders, then the linking together of our scholarly efforts is necessary. We must not forget that Nature creates nothing by one leap, but that the advance of civilization and thought has been made step by step—by the steady and regular process of evolution, and not by the mythological device of a sudden and complete creation. In this advance of human thought, in this growth of civilization, mind has co-operated with mind, country with country, one age with another.

This can be done only if we sink our narrow sense of national or sectarian individuality, our spirit of isolation, and fall into line with the world's workers in the higher branches of thought and research by agreeing on first principles and the uniformity of scientific method. In the realm of science every minute section of every subject has advanced by the co-operation of mind with mind, and in each successive age many workers have contributed their respective quotas of discovery to enrich the common stock of human knowledge.

Therefore, if we wish for the advancement of learning, then we must make arrangements for linking together the efforts of our own

workers among themselves, and also for bringing our scholars' labours into contact and co-ordination with the efforts now being made by seekers after truth in the other parts of the world.

We hear it said sometimes that the application of science to modern life is the solution of most of the problems which confront us. In that there is no doubt exaggeration, but it is certainly true that India with its great material resources to be developed, its industrial possibilities, its agricultural and engineering problems to be solved, offers wide scope to those whose talents lie in the directions of scientific research.

My own experience has taught me that mathematics are most valuable as an instrument of mental development apart from their absolute and growing necessity as the handmaid of many sciences They are an essential adjunct to almost every science known in the world. Any work, therefore, which increases our knowledge of mathematics tends to increase our knowledge or our means of obtaining knowledge in all these sciences.

We are proud to see here to-day not a few of the best known mathematical aristocrats in India. This province cannot boast of any renowned mathematician in the past. But, let us hope that this Conference will prove an inspiration and stimulus to the young students and products of our infant University to take to original research and to contribute their quota to the general knowledge of the world. The life and work of Ramanujan as a research-scholar can serve as a beacon light to many an young aspirant in the field of research in mathematics. Had Ramanujan lived longer, he would have brought more glory to our country as a first-rate research scholar and would have added to the sum total of research in the field of mathematics.

I will not detain you longer. I warmly thank you for accepting our invitation and coming over to Nagpur for this Conference.

Message from His Excellency the Governor of the Central Provinces.

I much regret that I am unable to be present at the opening of the Sixth Conference of the Indian Mathematical Society, as I should have liked to tell its members in person how glad we are here to see them, chiefly for their own sakes, but also because this is the first meeting of one of the learned societies which has been held in Nagpur since the opening of our new University. Mathematics is a subject the importance of which does not, perhaps, receive that general recognition which it merits, but its manifold applications in almost all branches of pure and applied science, some of which are now intimately connected with our daily life, cannot be gainsaid. It is not too much to assert that in many cases progress would be brought to a standstill without its assistance.

In the gradual extension of our knowledge which takes place year by year, Societies like the Indian Mathematical Society play an important part. From small beginnings this Society has developed until it now has a journal of its own, in which original papers are published; a circulating library, and regular meetings at which members may gather together to read their papers and exchange views It is a happy idea to hold these meetings at different University centres on account of the stimulating effect which such meetings have on the rising generation of students, some of whom, I trust, will, in the time to come, make their own contributions to mathematical knowledge. Next year at Nagpur we shall open our new College of Science and I hope that the better facilities which we shall be able to offer will induce other learned Societies to follow in your footsteps and honour us with their presence. I wish the present Conference every success.

(Sd.) MONTAGU BUTLER

The 24th December, 1928.

Governor, Central Provinces.

Report by
Rai Bahadur G. S. Chowla, M.A.
Hon. Joint Secretary.

MR. CHAIRMAN, LADIES AND GENTLEMEN,

This gathering marks an epoch in the history of our Society, which has this year completed 21 years of its existence, and is entering, we hope, upon a period of increased activity and usefulness. Since its foundation by Mr. V Ramaswamy Aiyar in 1907, the Society has made steady progress under the guidance of its successive Presidents: the late Mr. Hanumanta Rao, the late Mr. Middlemast, Dewan Bahadur Ramachandra Rao, Professor Wilkinson, Mr. Balak Ram and Mr. V. Ramaswamy Aiyar.

During the last twelve years we have had Conferences in Madras, Bombay, Lahore, Poona and Bangalore, and we are now meeting in this important centre of learning under the auspices of the University of Nagpur. These Conferences have provided a common meeting ground for mathematicians from all parts of India, and thus encourage advanced study and research. It will serve to show the interest evinced by our members in these periodical Conferences if I mention that the number of papers has grown steadily from 13 read in the First Conference held at Madras, to 30 in the last Conference at Bangalore. This time the number of papers contributed is 37.

We are glad that the eminent scientist, Dr. C. V. Raman, whom we are proud to count as one of our Honorary Members, will give the Inaugural Address.

Our thanks are due to Prof N. M. Shah, who was Honorary Joint Secretary for the years 1926 and 1927, and to Mr. S. Narayana Aiyar, who was Honorary Treasurer for a long period and did devoted work. Special mention must be made of the great debt of gratitude which the Society owes to Mr M. T. Naraniengar, who was the able editor of our Journal ever since its beginning. The Journal is at present under the distinguished editorship of Dr. R. Vaidyanathaswamy and Mr. A. Narasinga Rao, and I am glad to mention that from next year the size of our Journal is to be increased.

This year we have 22 more members, of whom two are life-members. This brings the total strength of our Society to about 250.

In conclusion, I must express on behalf of the Society, our grateful thanks to the Government and the University of Nagpur, as well as the members of the Reception Committee, for their generous support, without which it would have been impossible to hold this Conference. We also owe a great deal to the unselfish devotion of Professors Belekar and Mone and Dr. Dhar, who have worked hard to make this Conference a success.

Inaugural Address by

Dr. C. V. Raman, M.A., D.Sc. (Hon.), F.R.S.

NEW CONCEPTS OF MATTER AND RADIATION.

Most of the great discoveries in Physics made during the past forty years have been the result of experimental research. They have rarely been hit upon by accident, but have usually followed from the purposeful activity of the physicist in his laboratory seeking to gain knowledge from Nature at first hand. But successful experimentation means a background of ideas and of clear thinking, and that is where the theorist comes in. It is possible to reason clearly without the use of mathematical symbology. But experience has taught us that quantitative measurement and expression of natural phenomena is the surest way to reach a right understanding of them. We have to think quantitatively, and we can only do so by using the language and methods of the mathematician. The wonderful success of the organic chemists in analysing and synthesising tens of thousands of compounds is an illustration of how with little or no mathematics and a great deal of experimental research, it is possible to build up a vast body of purely empirical knowledge. But the deeper we desire to go in our understanding of Nature's workings, the more mathematical, and I may add, the more philosophical, we have necessarily to become.

The last forty years beginning with the discovery of the properties of electrical waves by Hertz in 1888 may be described as the heroic age of physics. An astounding wealth of new facts has been discovered, many of which are of a nature hardly reconcilable with the mechanical philosophy which dominated the nineteenth-century physics. A marked feature of this advance, more especially of recent years, has been the manner in which the latest weapons in the armoury of the mathematician have had to be requisitioned for the attack on the theoretical problems of modern physics. The theoretical physicist of to-day has to be an accomplished mathematician with gifts of intuition and imagination even superior to those necessary for success in experimental research. He will certainly have no inclination or leisure for experimental work and

will leave that to less gifted mortals. While the latter may sometimes make discoveries in the laboratory, the theorist will in most cases predict their results in advance and thus win glory. I hope this prospect will attract our young and gifted mathematicians and induce them to turn their attention to theoretical physics.

I will devote this address to the theoretical aspects of some recent discoveries in physics and their relation to our fundamental concepts of the nature of matter and radiation. To enable you to appreciate my discussion, I have to make some remarks of a preliminary nature.

In the early part of the nineteenth century, the science of optics made great strides forward by accepting the view that light and other forms of radiation consist of some kind of wave-motion capable of travelling through empty space. Later, the experimental discoveries of Faraday and the theoretical work of Clerk-Maxwell paved the way for the acceptance of the view that the waves of light are of an electro-magnetic nature. Heinrich Hertz brilliantly confirmed this idea by showing that waves having many of the physical properties of light could actually be generated in space using appropriate electrical circuits capable of oscillating with comparatively low frequencies. Maxwell's explanation of light as an electro-magnetic wave-motion was thus firmly established and may be regarded as a corner-stone of theoretical physics. It has never been seriously disturbed, though many phenomena were known or have been discovered which seem not at all easy to reconcile with it.

The latter half of the nineteenth century saw the rise of the science of spectroscopy. By raising a gas or a vapour to a sufficiently high temperature, or by passing an electric discharge through it, we can cause it to emit light, and this light when examined in a spectorscope shows numerous bright lines, and in some cases also bright bands or a continuous spectrum. All efforts to explain these spectra with the aid of mechanical or electrical models of the atom were unsuccessful until Bohr in 1913 showed the way by introducing his doctrine of the discrete states of matter. Bohr put forward the idea that the act of exciting an atom or a molecule to give out light is not a single process but takes place in two distinct stages. The first stage is that of energising the atom or molecule to make it pass into a condition *different* from the ordinary or non-luminous state. The second stage is for the atom or mole-

cule to return to a state of lower energy, giving up the extra energy in the form of radiation. The atom or molecule can exist only in one state at a time. This may at first sight seem to be a truism, but its real meaning is that the energy levels of the atom form a discontinuous series, without any intermediate states. In our classical idea of a dynamical system such as a vibrating string, we can imagine the string to be at rest or to be vibrating with a given amount of energy, or with any intermediate amount. This is not possible for atomic systems and any hope of representing the behaviour of an atom completely by ordinary dynamics is therefore futile.

The return of an atomic system from an energised state to its non-energised state or to any possible state of lower energy may be either spontaneous or be induced by some external agency. If the return is spontaneous, the difference of energies of the initial and final states must appear as radiation energy. This is the principal foundation of Bohr's theory. Different lines in the spectrum correspond to different quantities of energy radiated from the system. The relation between the energy-quantum and the frequency of the waves in the sense of Maxwell's theory is one of simple proportionality, the factor of proportionality being the Planck action constant.

As radiation is *emitted* by the atom or molecule in quanta, it follows logically from the doctrine of discrete states that it is also *absorbed* in quanta when the system passes from a state of lower to one of higher energy. Thus radiation seems always to appear in or disappear from atomic systems in bundles or energy-quanta. Many physicists have been troubled with the question whether in consequence of this, we should not also assume that it travels through space in quanta, and many discussions have appeared as to the size or volume of the quantum of radiation, its shape and spin, and of the manner in which the quanta crinkle their way along the curved lines of flow in an interference-field, and so forth. I am very doubtful myself whether such discussions have any value or significance and shall not tire you by speaking of them. I will pass on to consider some recent experimental discoveries which may possibly however have a bearing on the question of localising the paths of quanta in space.

I shall first refer to the brilliant work of Prof. A. H. Compton done

a few years ago for which he received the Nobel Prize in Physics last year. Compton showed that if X-rays fall upon matter, and the scattered rays are analysed by an X ray spectroscope, the spectrum shows a doubling of the lines present in the incident radiation. He gave a remarkably simple explanation of this phenomenon, by assuming that a quantum of radiation is a travelling corpuscle which hits one of the electrons in the scattering substance, and, as the result, is deviated from its straight path, the electron itself recoiling in another direction. It is obvious that in this process the quantum will lose some of its energy and the X-ray it represents will diminish in frequency, the missing energy of course being carried off by the recoil electron. Compton's explanation of his phenomenon is supported by measurements of the change of frequency of the X-rays and by actual observation of the recoil electrons; it has therefore received very general acceptance. I was present at Toronto in Canada in August 1924 when the physicists of the British Association listened to Compton's own account of his discovery and subsequently had a vigorous discussion on it. I was almost the only physicist present who voiced the opinion that there was nothing in the Compton Effect which really contradicted the classical wave-principles. In November 1927, I had an opportunity of re-examining this question and wrote a little paper in which I worked out for my own satisfaction a theory of the modified scattering of X-rays on lines quite different from that of Compton. I have thought it might be worth while to print this paper in the Indian Journal of Physics, and I am distributing copies of it to the members of this Conference.

The idea of my paper is briefly to regard the atom as a spherical enclosure containing Z electrons inside which they move about freely like the molecules of a gas. The paper discusses the effect of summing up the Z vibrations re-radiated by the electrons in the atom according to the ordinary principles of wave-optics. By investigating the magnitude and character of the resultant, we obtain in an astonishingly simple way the essential facts of the Compton Effect, namely, that we have a modified and an unmodified radiation, and that the ratio of the intensity of two depends on the atomic number of the scattering element, the angle of observation, and the wave-length of the incident radiation in just the way that we know experimentally to be the case. Further, the theory indicates that the modified scattering is of the nature of a 'fluctuation' phenomenon, in other words, that its intensity and distribution vary from

instant to instant in an arbitrary manner, and that these variations must be accompanied by corresponding simultaneous fluctuations in the state of the atom. This is just what is observed, and the fact that the classical wave-principles lead to it is very significant, and shows that the Compton Effect is to be regarded as a fluctuation in the electrical state of the atom induced by the incident radiation. By fluctuation here is meant a change from one possible to another possible state of the atom in the sense of Bohr

One rather violent kind of fluctuation in the sate of an atom is for it to throw off a loosely-bound outer electron, and in fact, this actually happens at high temperatures, the atom becoming ionized. The Compton Effect is just the same kind of fluctuation, induced in this case at the ordinary temperatures by the impact of external radiation. The classical wave-principles suffice to indicate that such fluctuation must occur in the present case and even enable us to calculate the intensity of the modified X-radiation which accompanies it. In my paper I discuss also the question of the change of frequency of the modified scattering and explain why Compton's way of deriving it gives the same result as when we adopt the classical view that the radiation from an electron consists of spherical waves.

The treatment of the Compton Effect outlined above seems to make it easier to reconcile, in a physically intelligible way, the classical and quantum points of view regarding the process of radiation from atoms. In view of its simplicity, it may also prove of service in working out the theory of the Compton Effect, not merely for single atoms, but also for whole groups of them as we find in solids and liquids, and for finding how the free electrons are distributed in space in electrically conducting solids such as metals. Another important point is that this way of viewing the Compton Effect naturally suggests that it is only one of several possible types of modified secondary radiation. It is not necessary for the atom to undergo such a violent fluctuation in its state as the ejection of an electron. The impact of radiation may induce the atom to pass from the state of lowest energy to another of higher energy in which the electrons remain bound to it. In this case, we shall find the incident quantum of radiation is, so to say, divided up, part of it being absorbed by the atom, raising its energy level, and the remaining part of the quantum going off as a new radiation of diminished frequency.

While the Compton type of scattering is observable only with X-rays and other radiations of very short wave-length, the new type of radiation indicated above is a universal phenomenon. It was first observed at Calcutta with ordinary light. As early as 1923, it had been noticed in our investigations on the scattering of light, that when sunlight filtered through a violet glass passes through water or ice, the track of the beam of light continues to be visible through a green glass. Since the green and violet glasses taken together are completely opaque to light and are thus complementary to each other, it follows that violet light is actually transformed in part into green light by the molecules of the water or ice. Subsequently the phenomenon was studied also in many other solids and liquids and the results were published from time to time. The theoretical investigations on the nature of the Compton Effect on which I was engaged towards the end of 1927 gave me a clue to the real nature of the optical phenomenon encountered by us in light-scattering. This clue was rapidly followed up with very gratifying results.

The phenomena of the new radiation appear in their most interesting form when we use monochromatic light such as that of a mercury lamp and analyse spectroscopically the light after it is scattered within a transparent medium, *e g.*, vapour, liquid, or crystal. A great many new lines appear in the scattered spectrum which are not present in the light of the mercury arc. Most of these lines represent frequencies of radiation lower than those of the mercury responsible for their generation: Some lines of higher frequency than the corresponding mercury lines are also found. The following chemical equation indicates how the new lines of both kinds arise:

$$\begin{array}{lll} \text{Molecule} + & \text{Radiation} & \rightarrow \text{Molecule} + \text{Radiation} \\ \text{(normal)} & \text{(high frequency)} & \leftarrow \text{(excited) (low frequency)} \end{array}$$

We have the normal reaction when the molecule is initially in the normal state, and the reverse reaction when the molecule is initially in the excited condition owing to thermal agitation.

It does not lie within the scope of this lecture to describe the many interesting phenomena observed in connection with the new type of secondary radiation, or its applications in diverse fields of physics and chemistry. The subject is receiving attention from a great many

physicists and chemists throughout the world, and its literature is growing at a great pace. I am only concerned to-day with some of the theoretical aspects of the phenomenon. Some will no doubt choose to consider it a proof of the quantum theory of radiation. Personally I see in it nothing really contradictory to the classical wave-principles when taken together with the Bohr theory of discrete states of matter. If we can cut up a quantum of radiation or add to it, as experiment shows, and thus diminish or increase the frequency of the radiation by any desired amount, it seems to me difficult to assign to the quantum a corporeal existence such as that which we naturally associate with an electron or proton. The idea of adding or subtracting frequencies arises in classical dynamics when we deal with anharmonic oscillators, and there is nothing specially of a quantum character involved in it. What is significant is the relation between the intensities of the lines of diminished and enhanced frequencies. The latter are usually much weaker and appear only when the molecules are excited independently by thermal agitation or otherwise, and this is strong support for the idea of discrete energy levels as enunciated by Bohr. We have to modify our dynamics to make it suit our atoms, but I do not believe that we shall have to make any startling changes in our viewpoint as regards the nature of radiation.

In conclusion, I desire to thank the Society very sincerely for the great distinction of election to the Honorary Membership which they have conferred upon me. I know the interests of the Society centre largely in pure mathematics. But I know also that some amongst you have leanings towards Physics. I earnestly trust that they will turn their attention towards the problem of radiation and its inter-relations with matter which still awaits complete solution.

Proceedings of the Business Meeting held at 2 p.m. on the 24th December 1928.

Mr. V. RAMASWAMY IYER, President, in the Chair.

1. Prof. C. V. Raman suggested that the question of holding the Conferences of the Society in the same place as the Indian Science Congress be considered.

Resolved that the President, Prof. Raman and the Honorary Joint Secretary form a Sub-Committee in order to negotiate with the Indian Science Congress to formulate a scheme of co-operation in the matter of holding Conferences, and to put the scheme before the Managing Committee of the Indian Mathematical Society.

2. Mr. Narasinga Rao suggested that a Ramanujan Memorial Prize be awarded every year for work of original merit.

The President and other speakers felt that once in three years a Memorial Prize might be given to the author of work of outstanding merit but that this could be done only when the funds of the Society improved.

3. Mr. Balak Ram made a suggestion that some propaganda work should be carried out to get grants from Universities, and private individuals to secure funds for the Library and for publications of the Indian Mathematical Society.

This suggestion was accepted. It was decided to draw up a pamphlet giving a history of the Society and its activities.

4. Mr. Balak Ram suggested that copies of our Journal should be sent to important learned bodies outside India, and that the two parts of the Journal should be actually separated.

This suggestion was to be circulated to the Managing Committee.

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